The cloud cover vertical distribution and its diurnal cycle observed from Multi-Geostationary data

G. Sèze(1), C. Stubenrauch(1), A. Feofilov(1), J. Pelon (2), H. Legleau(3), M. Derrien (3)

(1)LMD, CNRS/IPSL et UPMC. (2)LATMOS, CNRS et UPMC (3) METEO-France/CMS

CONTEX

A coherent cloud mask, cloud type classification and cloud top pressure maps with a high spatial and temporal resolution in the tropical belt using geostationary satellite data (GEO: GOES-E, GOES-W, MTSAT and MSG) has been elaborated in the frame of the MEGHA-TROPIQUES experiment.

HERE

The diurnal cycle of the GEO cloud cover and cloud cover type occurrence over ocean and land for one summer and one winter north hemisphere season.

Comparison with the 0130 AM and PM AIRS and CALIOP measurements and the 0930 AM and PM IASI measurements

Background : a detail comparative analysis between the GEOs and CALIOP already performed for the same summer season (CREW3, Madison ; EUMETSAT 2014 ; Seze et al. submitted)

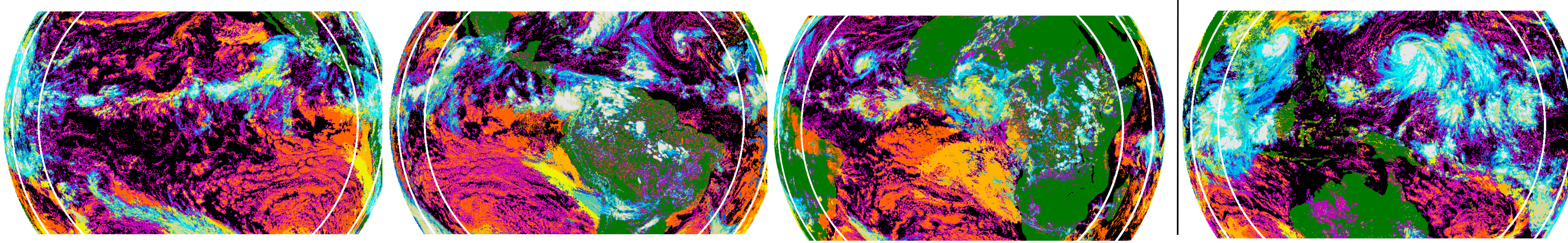
Elaboration of cloud cover maps over the tropical belt using geostationary satellite data

➔ **Multi-spectral threshold technique developed for the radiometer SEVIRI on board MSG by the *Satellite Aplication Facility for NoWCasting* (Marcel Derrien and Hervé Legleau, 2005, 2009)**

➔ **5 satellites in the minimal configuration with at least one visible channel, two IR channels (10.8μ, 3.9μ), one WV or CO2 sounder channel**

For the moment one missing satellite

GOES-W 4 channels | GOES-E 3 channels | SEVIRI 5 channels | MTSAT 4 channels



Land | Sea | Very Low | Low | Medium | High | Very Hig. | Th. Cir. | Cirrus | Thk. Cir. | Th. Above | Partial

The white curves indicate for each satellite the 72.5° VZA and 55° VZA.

For partial cloud cover and for some GOES and MTSAT cirrus cloud top pressure is not available.

The CALIOP, IASI and AIRS cloud cover

- The version 3 of the cloud layer operational product for the CALIOP 5km average profil and 333m profile are used.

The CALIOP cloud cover include all the thin high cloud with optical depth above 0.1 and all the small clouds detected at scale smaller than 5km.

- The AIRS and IASI cloud cover are obtained both with the LMD algorithm and using the ERA interim atmospheric profils.

DAY to NIGHT CHANGES IN THE DATA:

Lidar SNR smaller during daytime than nighttime.

Use of visible channels in the GEO retrievals during daytime. Solar contribution in the 3.7 channel during daytime. For GOES-E no 12.0 channel.

No change in the sensitivity of the AIRS and IASI measurements between day and night.

Limitation of the field of view of each GEO to VZA < 55°.

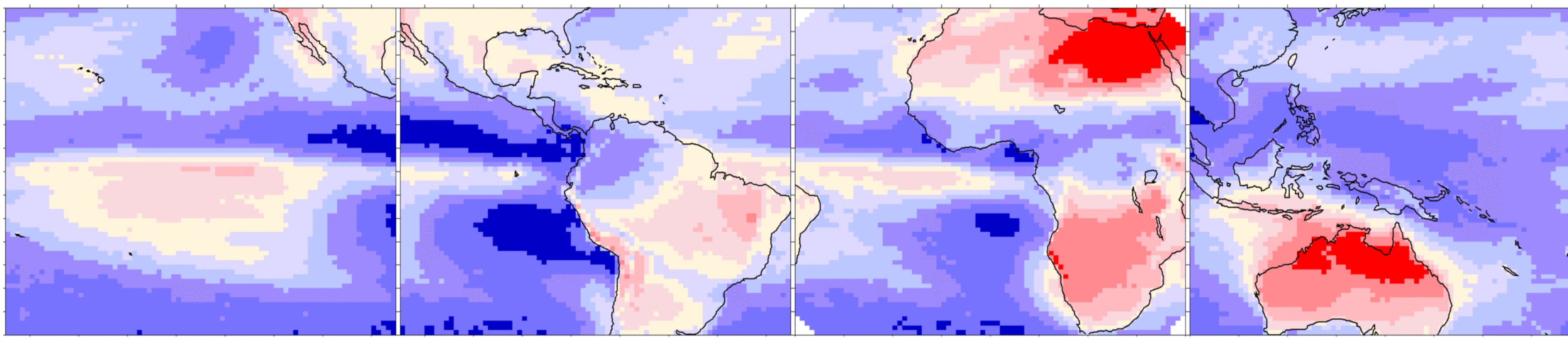
CLOUD OCCURRENCE FREQUENCY MAP

Average over the diurnal cycle (16 time steps)

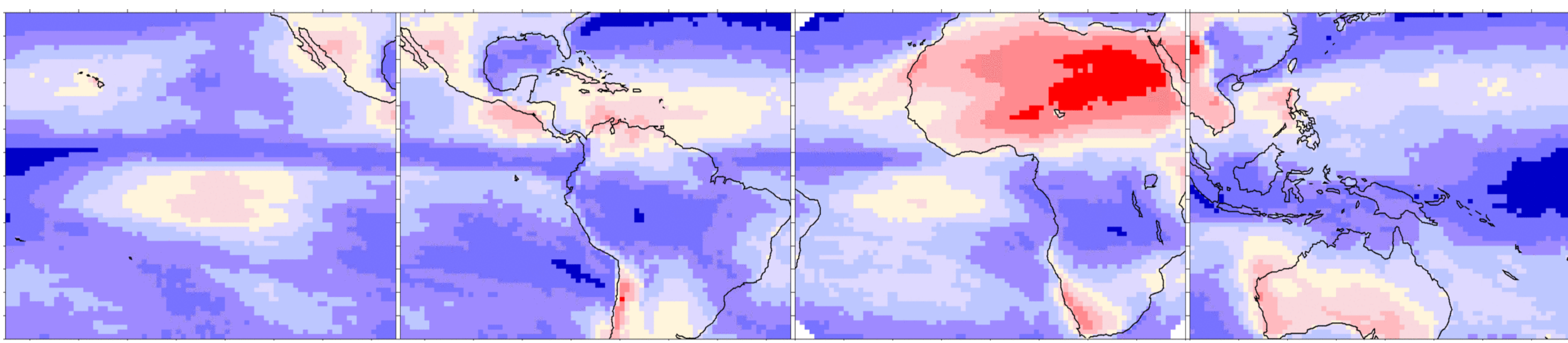
GEO VZA < 55°.

June, July, August, September 2009 (JJAS)

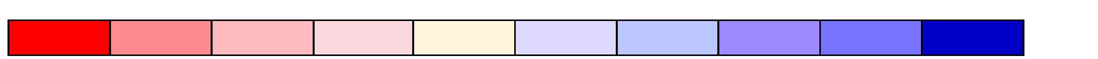
GOES-W **GOES-E** **SEVIRI** **MTSAT**



December 2009, January, February 2010 (DJF)



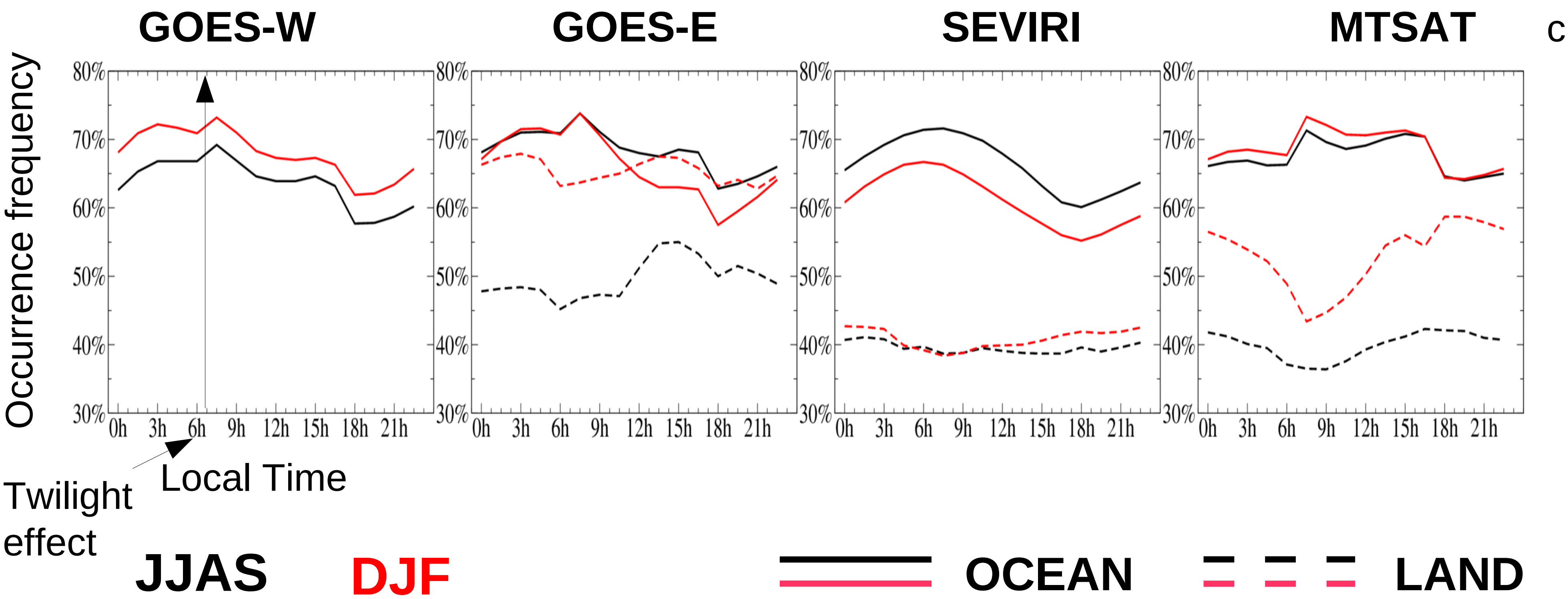
1°x1° grid box



CREW4, Grainau, March 2014

DIURNAL CYCLE of CLOUD OCCURRENCE FREQUENCY

JJAS and DJF - 1H30 time step



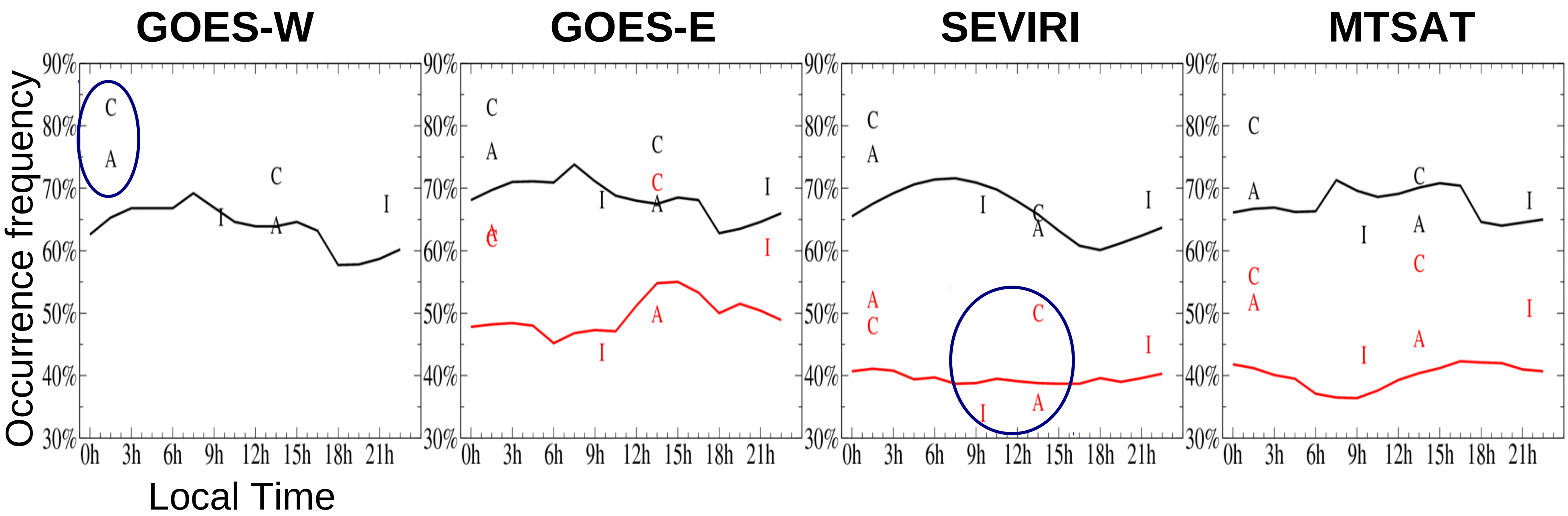
Over ocean COF maxima in the early morning
Over land COF minima in the morning

Over ocean no change in the diurnal cycle COF curve shape between JJAS and DJF
Over land large increase in COF in DJB in relation with the ITCZ southward shift.

DIURNAL CYCLE of CLOUD OCCURRENCE FREQUENCY

JJAS

GEO : 1h30 time step - CALIOP and AIRS : 0130 AM and PM – IASI : 0930 AM and PM



C: CALIOP A : AIRS I : IASI — **OCEAN** — **LAND**

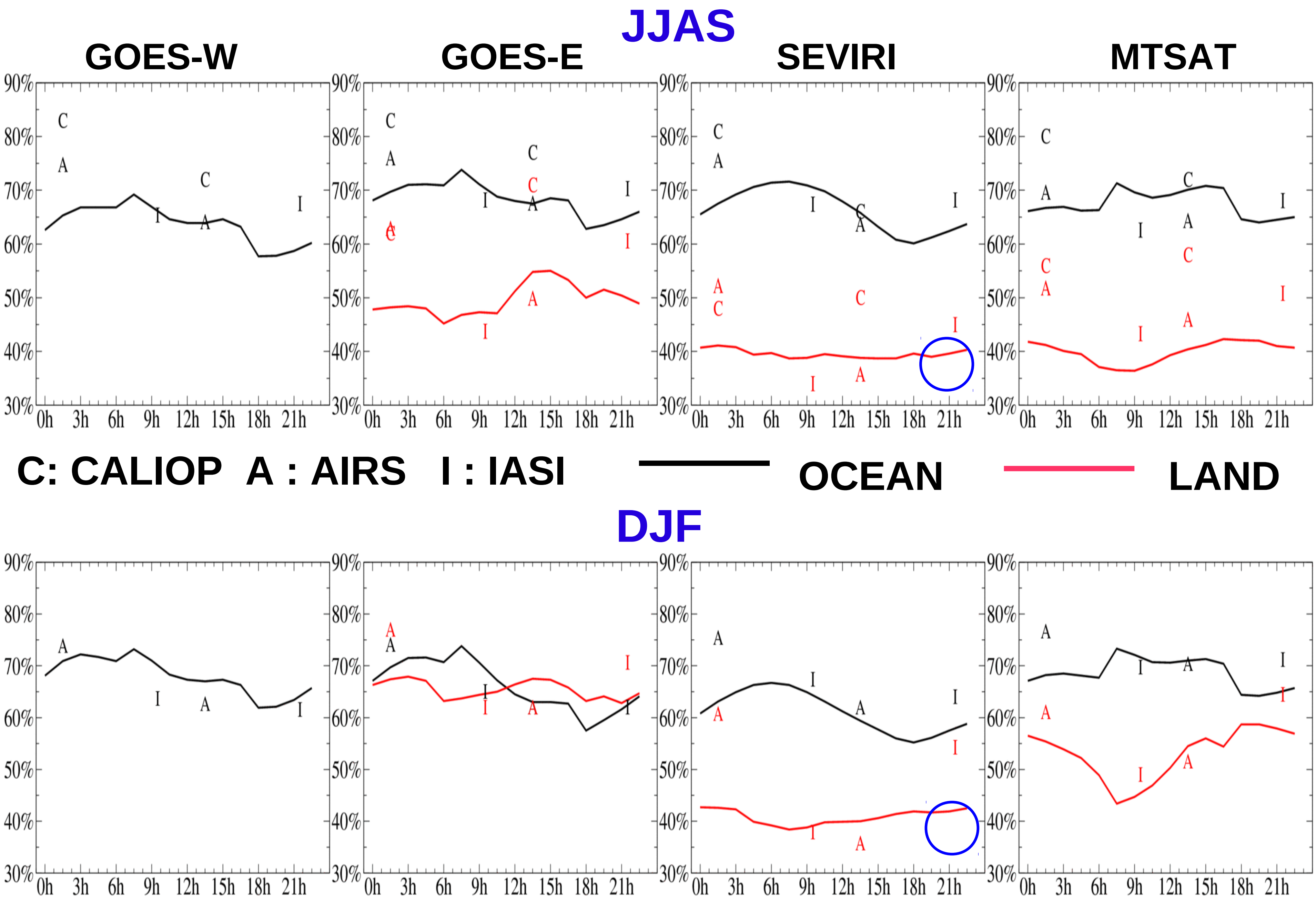
CALIOP cloud layer with OD < 0.1 not taken into account

Between GEO COFs and CALIOP COFs , bias larger than 10% at 0130AM.
At 0130 PM, bias increase over land and bias decrease over ocean.

Between the GEO COFs and AIRS and IASI COFs, compared to the GEO-CALIOP bias, smaller bias over ocean and during daytime over land.

CALIOP , AIRS : maxima of COFs at 0130AM over ocean.

DIURNAL CYCLE of CLOUD OCCURRENCE FREQUENCY



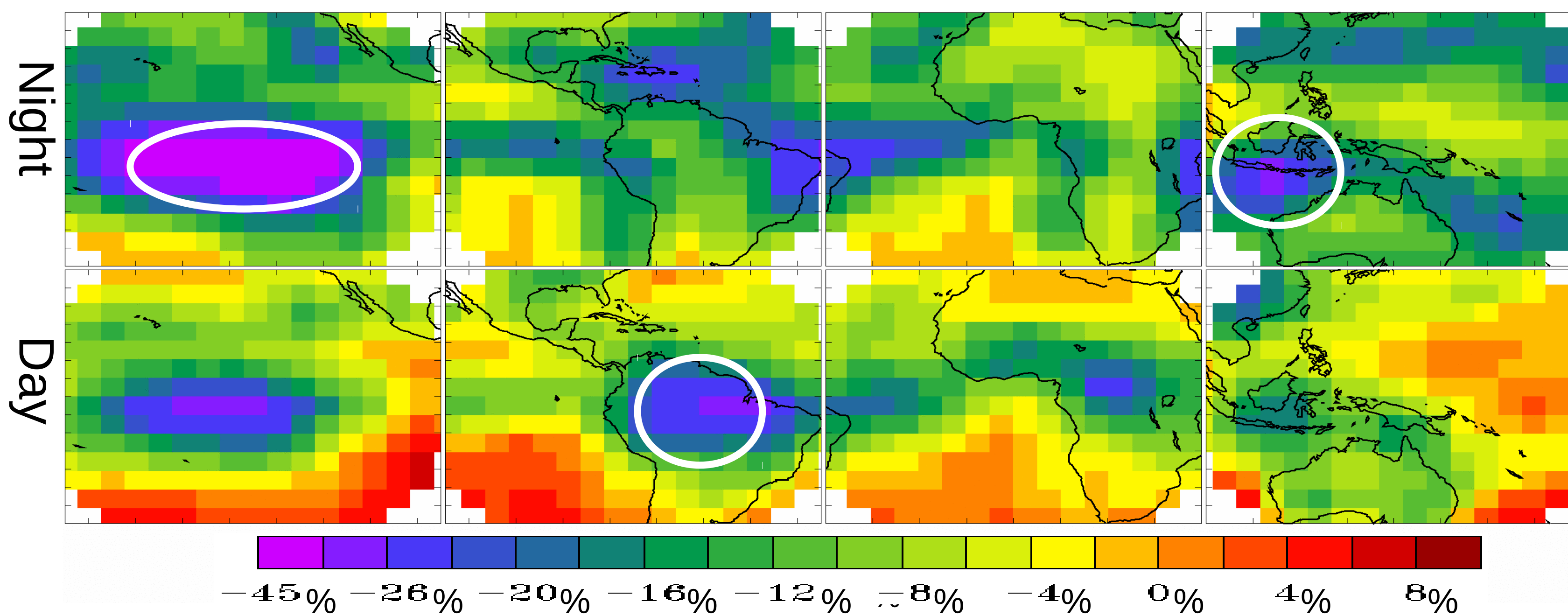
Between the two seasons the change in bias can be larger than the change in COFs

NIGHT and DAY COF for the 2009 JJAS period

	GOES-W			GOES-E			SEVIRI			MTSAT		
	G-W	CAL	Bias	G-E	CAL	Bias	SEV	CAL	Bias	MTS	CAL	bias
Ocean night	66%	83%	-17%	71%	83%	-12%	69%	81%	-12%	67%	80%	-13%
Ocean day	65%	72%	-7%	66%	70%	-4%	61%	66%	-5%	70%	72%	-2%
Land night				48%	62%	-14%	38%	48%	-10%	43%	56%	-13%
Land day				53%	71%	-18%	39%	50%	-11%	40%	58%	-18%

Bias between 10% and 18% excepted over ocean during daytime

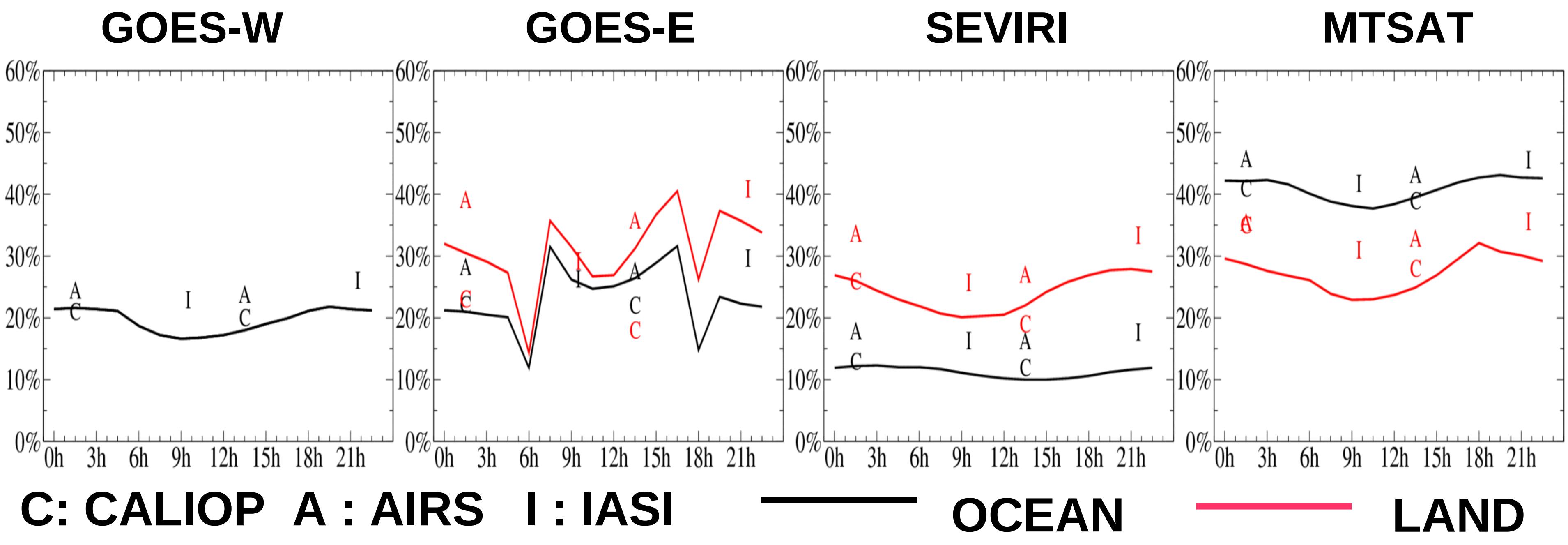
GEO minus CALIOP COF



DIURNAL CYCLE of CLOUD OCCURRENCE FREQUENCY - JJAS

HIGH CLOUD

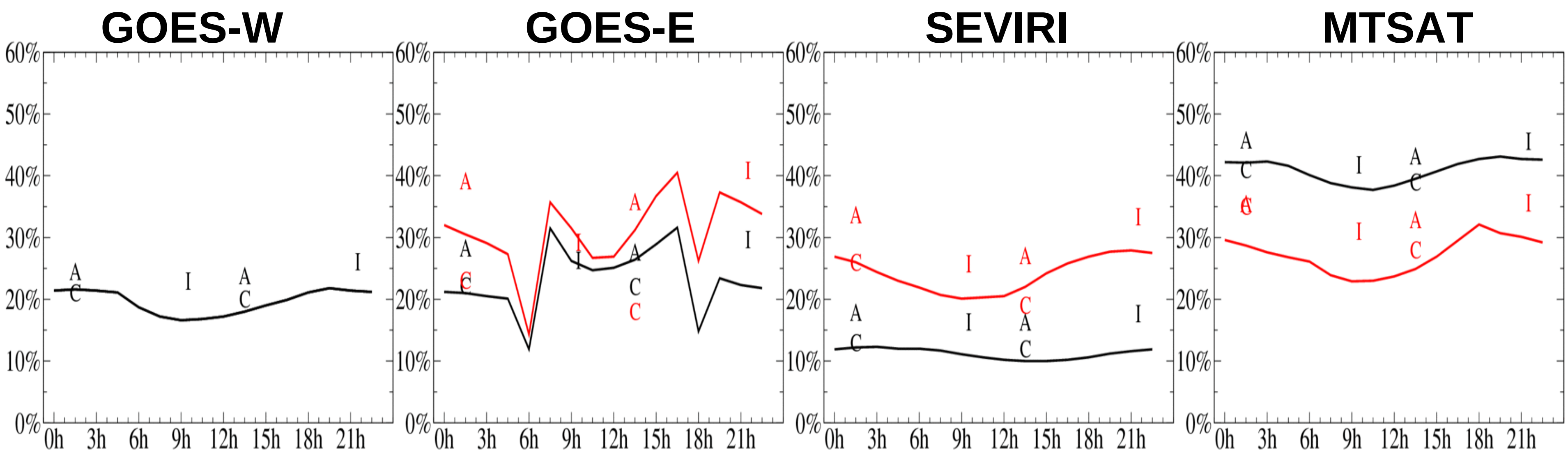
GEO : 1h30 time step -AIRS : 0130 AM and PM – IASI : 0930 AM and PM



DIURNAL CYCLE of CLOUD OCCURRENCE FREQUENCY - JJAS

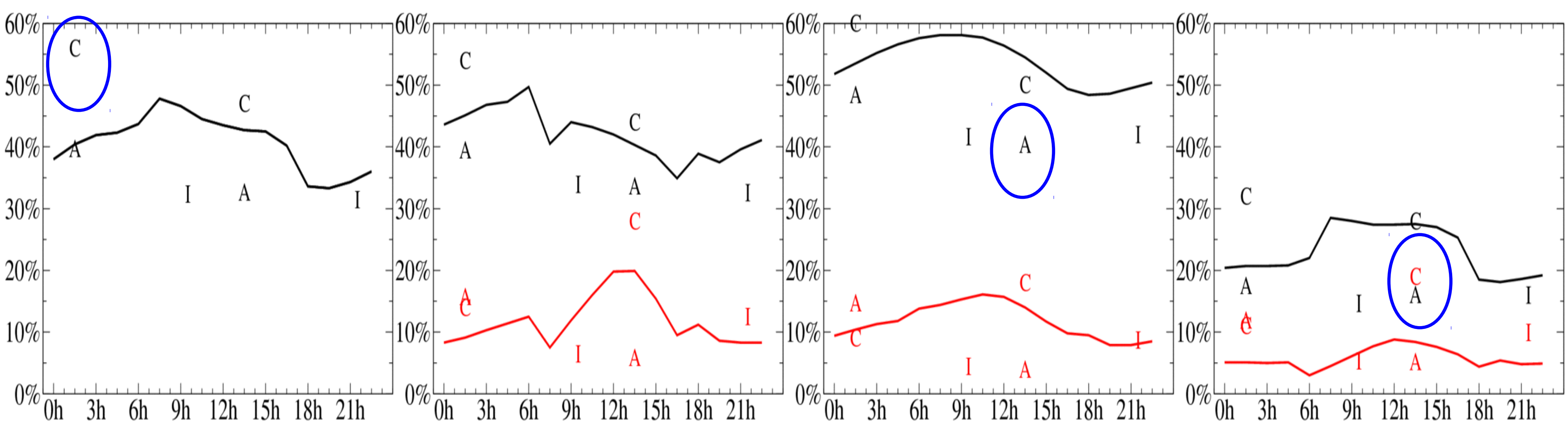
HIGH CLOUD

GEO : 1h30 time step -AIRS : 0130 AM and PM – IASI : 0930 AM and PM



C: CALIOP A : AIRS I : IASI — OCEAN — LAND

LOW CLOUD



CREW4, Grainau, March 2014

CONCLUSION (1)

When the field of view of each GEO is limited to VZA < 55° and CALIOP cloud layers with optical thickness smaller than 0.1 or detected at a scale larger than 5km are not taken into account:

➔ **A common behaviour of the GEO against CALIOP depending on cloud type is found when both statistical and pixel to pixel comparison are performed**

Excepted over ocean during daytime, the CALIOP COF's are larger than the GEO COF's by more than 10% . The largest bias (15%-17%) are found for land during daytime for MTSAT and GOES-E and over ocean during nighttime for GOES-W.

The regional variations around these means values are large. These variations are related to the frequency of low clouds and particularly broken low clouds above the regions**.** The GEO COF negative bias reach 30% at 0130LST in region of very small low clouds.

CONCLUSION (2)

These first results on the comparison of the CALIOP, GEO, AIRS and IASI COF cloud and cloud type bias as a function of local time, are generally consistent : the changes in bias depend both in cloud types and change in instrument sensitivity between day and night.

Over ocean, the large amount of low clouds, make the bias large between the GEO and CALIOP during nighttime. Over land the increase of low clouds during daytime increases the bias between the GEOs and CALIOP.

The bias between the GEOs and AIRS and IASI are comparable. The GEOs minus AIRS(IASI) bias is negative during nighttime and is close to null or positive during daytime when the GEOs retrieval uses the VIS information.

As expected, AIRS and IASI HIGH COF are larger than the GEOs HIGH COF but only by few percents. The GEOs LOW COF during daytime can be more than 10% above those of AIRS (IASI)

Futur → need to go further in this comparative analysis. Use of combine GEOs AIRS, IASI Cloud Cover parameters to describe the cloud cover diurnal cycle.

THANKS TO SATMOS(INSU-METEO-France), ASDC(NASA) AND ICARE(CNES) FOR THE DATA PROVISION

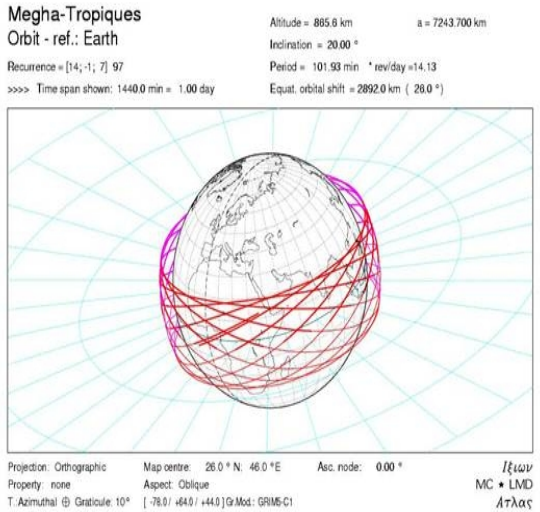
Thank you

MEGHA-TROPIQUES aims to measure with a high repetitivity radiances linked to radiative fluxes, water vapour and precipitation:

The 20 degree orbit at 870km of altitude allows up to six observations by day of the same region.

A MW imager for rain and clouds (MADRAS),
a MW sounder for water vapour (SAPHIR) and
a wide band instrument for radiative fluxes (ScaraB)

The geostationary satellite VIS and IR imagers complete this set of instruments for the cloud scene identification and cloud top pressure retrieval at high spatial scale, the tracking of cloud convective systems the multi-instrument precipitation retrieval.



The cloud scene identification and cloud top pressure will be used:

- **as input in the SAPHIR-MADRAS water-vapour profile retrieval.**
- **for the validation of the ScaraB cloud scene classification**
- **to better characterize clouds associated to convective systems**
- **to observe the low and mid-level cloud cover**